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(54) **LIGHT-EMITTING DIODE LUMINAIRE WITH DYNAMIC CONVECTION COOLING**

(57) The invention relates to the field of lighting, and specifically to a lighting devices and / or light sources with semiconductor device - light emitting diodes and can be used as an LED light source for outdoor, industrial, domestic and architectural lighting design. The task to be solved by the claimed technical solution is to create a simple to manufacture high-efficiency lighting device. Technical results achieved as a result of solving the problem, consist in: increase efficiency of the device, increasing the lifetime of the device, simplifying device manufacture. The LED luminaire with dynamic cooling convection comprises at least one hollow housing of a thermally conductive material on the outer surface of which is secured LED light source that is connected to a power source. The housing is a segment of a hollow pipe with open ends and the LED light source, for which the LED module is used, is installed in close proximity to one of the open ends of the housing. In some cases of implementation LED module can be mounted on side surface of housing. In some cases of implementation LED module can be secured at the end surface of the housing for entry of air into the interior of the housing. In various cases, the implementation of LED module may be secured to the housing surface via a releasable or permanent connection. Preferably, that between the surfaces of the LED module and the housing was placed a layer of thermally conductive paste material. In some cases of implementation the LED luminaire may comprise n struc-

turally interconnected hollow housings, where $n \geq 2$, each of which represents a segment of a hollow pipe with open ends; in close proximity to one of which the LED module is installed. In various cases of implementation the housings of two or more fixtures can be connected to each other via a releasable or permanent connection. In various cases of implementation the housings of two or more fixtures can be connected by means of a rigid or swivel. In some cases of implementation the housings of two or more fixtures can be connected to each other so that their longitudinal axes are parallel to each other. In other cases of implementation the housings of two or more lamps may be connected to each other so that their longitudinal axes lie in one another at an angle of range $10^\circ - 170^\circ$. In some cases, the housings of the two or more luminaires are interconnected via adjacent contact surfaces. In some cases, the housings of the two or more luminaires are interconnected with a gap between adjacent surfaces. In various cases, each of the housings may have a rectangular or square, or round, or triangular, or shaped profile. Preferably, that the housing is made of an aluminum pipe of rectangular shape with exterior dimensions of width - 100.0 mm, the height - 30.0 mm, with a wall thickness of 2.0 mm. Preferably, the length of the body is in the range of 0.2 m - 0.5 m. Preferably, the power LED module is in the range of 20 - 70 watts. Preferably, the LED luminaire comprises means for fastening to the supporting surface.

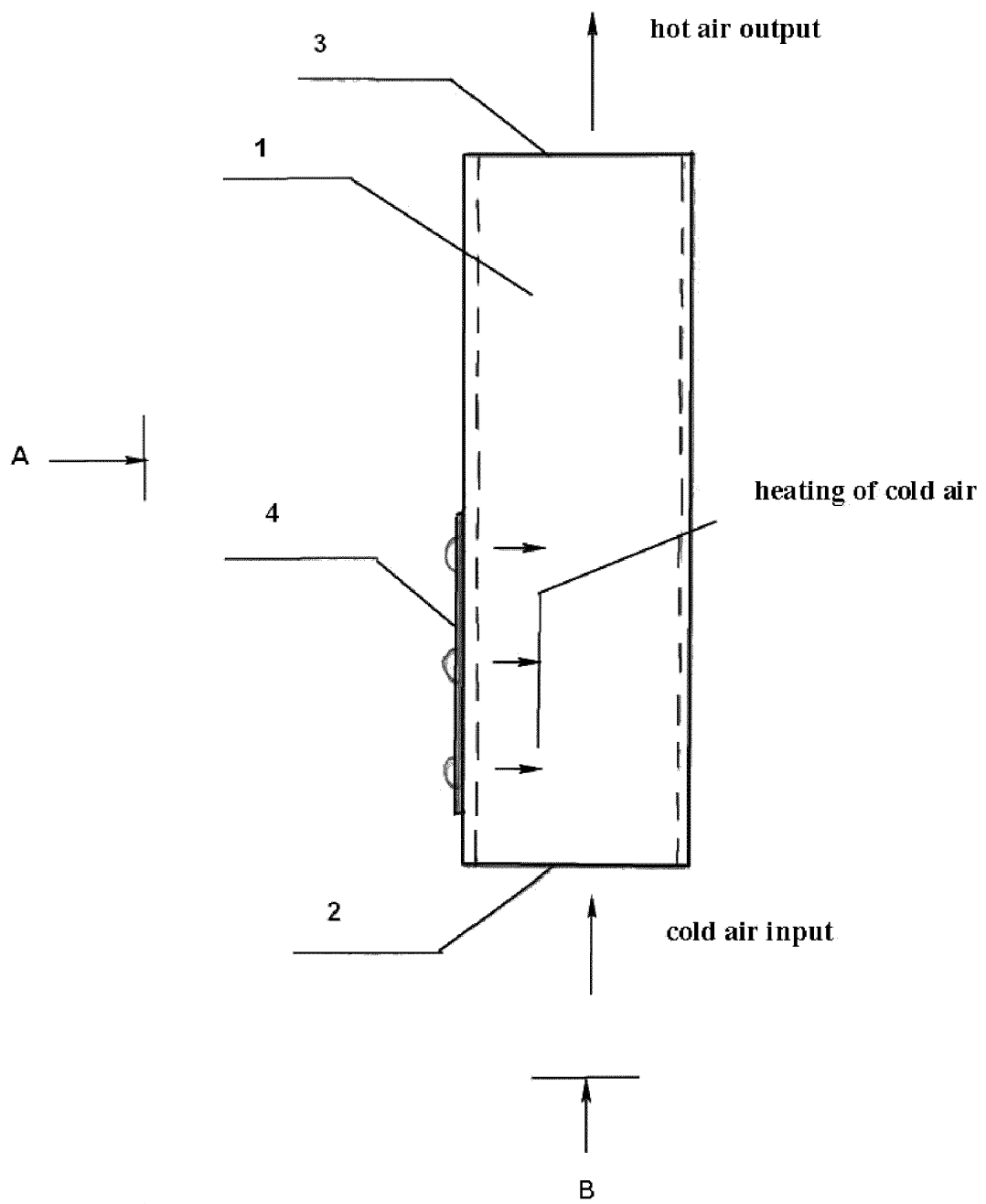


FIG.1

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The invention relates to the field of lighting, and specifically to lighting devices and / or light sources with a semiconductor device - light emitting diodes.

[0002] The invention can be used as a LED light source for outdoor, industrial, domestic and architectural lighting design.

Definition of terms:

[0003] LED or a light emitting diode (LED, Light-emitting diode) is a semiconductor device with an electronic pn junction, which creates optical radiation by passing electric current through it (<http://ru.wikipedia.org/wiki/Светодиод>).

[0004] LED Module is a printed circuit board - PCB with LEDs mounted on it, and possibly with electronic components and secondary optics (http://light.rtcs.ru/products/list.php?SECTION_ID=89). LED modules (clusters) are sealed units of high-impact polystyrene with LEDs located inside. (http://nlt-trading.ru/catalog/index.php?SECTION_ID=4).

[0005] LED lighting devices have several advantages - high luminous efficiency, low power consumption, long service life, high security, compactness and light weight, resistance to mechanical stress, purity of light, radiation directivity and others.

Description of the Related Art

[0006] A known LED lighting - a lamp containing sections of LEDs connected to the power supply, which is connected to the mains alternating voltage, where as a heatsink a luminaire housing made of a thermally conductive material is used, the section of LEDs is mounted on the heatsink.

[0007] As a radiator cooling unit - a heatsink a block of metal elements can be used, which is located both on the housing and inside the housing, and to increase the heat power dissipated by the LED the heatsink may have forced cooling, for example, by means of a blower (patent RU2313199 for an invention "Lamp" IPC H05B33/02, F21S4/00, publ. 20.12.2007). The disadvantage of this lamp is the inefficient heat removal-dissipation at high thermal loads, which leads to the reduction of the lifetime of the lamp.

[0008] A known lamp containing a LED light source, as well as a membrane blower motor, placed in the housing, having the nozzle openings and a hollow radiator, where the outer surface of the radiator is provided with cooling fins, wherein the radiator and the fan housing are installed so that the intercostal spaces of the radiator

form channels for the air flow generated by the fans and discharged through the nozzle openings of the housing. The fan housing and a light source are situated in the radiator cavity, when the lamp comprises a tubular installed over the radiator and closed at the top housing, in the bottom and top parts of which through openings are made (patent RU111253U for the utility model "lamp with active cooling," IPC F21V29/02, publ. 10.12.2011). The disadvantage of this lamp is its structural complexity and lack of operational reliability.

[0009] The known LED lamp of convection cooling with respect to the essential features of the claimed invention and selected as a closest prior art comprises the hollow housing of a thermally conductive material on the outer surface of which a LED light source is mounted that is connected to the power supply via a flexible cable. An optical lens covering the LEDs has an annular shape; the body-housing is a radiator and has a vertical radiator grille (patent RU2433577 for the invention "LED lamp with high efficiency convection cooling," IPC H05B33/00, publ. 10.11.2011). Performing of the outer side surface of the housing ribbed in the form of vertical ribs gratings requires the machining of the external surface of the housing by a cutter or a mill, which makes the manufacturing of the known lamp laborious. Furthermore, the lamp is characterized by the low efficiency of heat exchange between the internal volume of the hollow housing and the environment.

SUMMARY OF THE INVENTION

[0010] The task to be solved by the claimed technical solution is to create a simple to manufacture high-efficiency lighting device.

[0011] Technical results achieved as a result of solving the problem, consist in:

- increasing the efficiency of the device;
- increasing the lifetime of the device;
- simplifying the manufacture of the device.

[0012] These technical results are achieved by the fact that a LED luminaire with dynamic cooling convection comprises at least one hollow housing made of a thermally conductive material, on the outer surface of which there is secured a LED light source that is connected to a power source. The housing is a segment of a hollow pipe with open ends, where a LED module is used as the LED light source and installed in close proximity to one of the open ends of the housing.

[0013] In some cases of implementation the LED module can be mounted on the side surface of the housing.

[0014] In some cases of implementation the LED module can be secured on the end surface of the housing with a possibility of entry of air into the interior of the housing.

[0015] In various cases of implementation the LED module may be secured on the surface of the housing via a releasable or permanent connection.

[0016] Preferably, in between the surfaces of the LED module and the housing a layer of a thermally conductive paste material is placed.

[0017] In some cases of implementation the LED luminaire may comprise n structurally interconnected hollow housings, where $n \geq 2$, each of which represents a segment of a hollow pipe with open ends; in close proximity to one of which the LED module is installed.

[0018] In various cases of implementation the housings of two or more luminaires can be interconnected via a releasable or permanent connection.

[0019] In various cases of implementation the housings of two or more luminaires can be interconnected by means of a rigid or hinged connection.

[0020] In some cases of implementation the housings of two or more luminaires can be interconnected so that their longitudinal axes are parallel to each other.

[0021] In other cases of implementation the housings of two or more luminaires may be interconnected so that their longitudinal axes are located to each other at an angle of range 10° - 170° .

[0022] In some cases, the housings of two or more luminaires are interconnected with adjacent contact surfaces.

[0023] In some cases, the housings of two or more luminaires are interconnected with a gap between the adjacent surfaces.

[0024] In various cases, each of the housings may have a rectangular or square, or round, or triangular, or figure shape.

[0025] Preferably, the housing is made of an aluminum pipe of a rectangular shape with the exterior dimensions of width - 100.0 mm, height - 30.0 mm, with a wall thickness of 2.0 mm.

[0026] Preferably, the length of the housing is in the range of 0.5 m - 2 m.

[0027] Preferably, the output of the LED module is in the range of 20 - 70 W.

[0028] Preferably, the LED luminaire comprises means for fastening to the supporting surface.

[0029] The comparative analysis of the claimed invention with the closest prior art showed that in all cases of execution, it differs from the known closest technical solution by:

- implementation of the housing as a segment of a hollow pipe with open ends;
- using a LED module as the LED light source;
- implementation of the LED module installed in close proximity to one of the open ends of the housing.

[0030] In some cases, the invention differs from the known closest technical solution by:

- implementation of the LED module secured on the side surface of the housing;
- implementation of the LED module secured on the end surface of the housing with a possibility of entry of air into the interior of the housing;
- implementation of the LED module attached to the surface of the housing by means of a releasable or permanent connection;
- presence of a layer of a thermally conductive paste material between the surfaces of the LED module and the housing;
- presence of n structurally interconnected hollow bodies, where $n \geq 2$;
- implementation of the housings interconnected via a releasable or permanent connection;
- implementation of the housings interconnected by means of a rigid or swivel connection;
- implementation of the housings interconnected in such a manner that their longitudinal axes are parallel to each other;
- implementation of the housings interconnected in such a manner that their longitudinal axes are located to each other at an angle of the range of 10° - 170° ;
- implementation of the housings interconnected with the adjacent contact surfaces;
- implementation of the housings interconnected with a gap between the adjacent surfaces;
- implementation of the housing having a rectangular, or square, or circular, or triangular, or figure shape;
- implementation of the housing of the aluminum pipe of a rectangular shape with the exterior dimensions of width - 100.0 mm, height - 30.0 mm, with a wall thickness of 2.0 mm;
- implementation of the length of the housing constituting the range of 0.2 m - 0.5 m;
- using LED module power in the range of 20-70 W;
- presence of the fixing means to the supporting surfaces.

[0031] The proposed design of the cooling device has improved the thermal parameters by increasing the efficiency of convective thermal exchange, which provides the removal from LEDs of substantially all of the heat

they emit and transmitting it to the environment. This increases the light output of the LEDs and their lifetime, and consequently, the lifetime of the lighting device. In addition, more intensive cooling allows to apply higher current values to the LED module, thereby increasing the efficiency and the power of the lighting device as a whole. Using the hollow pipe as the housing does not require additional milling or other processing of the outer surface, which reduces the costs and simplifies the manufacture of the product. Implementation of the lamp, containing the n number of the housings, different variants of their connections allow to create the lamps of different power and design, extending their functionality and application. Execution of the housing as a rectangular shape pipe with the exterior dimensions of width - 100.0 mm, height - 30.0 mm, with a wall thickness of 2.0 mm allows to use varietal rolling preforms substantially reducing their manufacturing costs. Implementation of the housing from aluminum characterized by high thermal conductivity and heat dissipation provides the effective and efficient convection cooling of the LEDs. Experimental tests have shown that the body length from 0.2 m to 0.5 m provided the most effective cooling. When the body length is less than 0.2 m air does not have time to cool, and when the body length is more than 0.5 m, air draft between the input and the output is reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The proposed invention is illustrated by schematic drawings of FIGS. 1 - 8.

FIG. 1 shows a schematic drawing of a LED luminaire with dynamic convection cooling with a rectangular housing where a LED module is attached to the side surface of the housing, side view.

FIG. 2 is a view A (front) of Fig. 1

FIG. 3 is a view B (top) of Fig. 1

FIG. 4 shows a schematic drawing of the LED luminaire with dynamic convection cooling with a rectangular housing where the LED module is attached to the side surface of the housing with partial incision, side view.

FIG. 5 shows a schematic drawing of the LED luminaire with dynamic convection cooling with a rectangular housing where the LED module is attached to the end surface of the housing, general view.

FIG. 6 shows a schematic drawing of the LED luminaire with dynamic convection cooling with a circular shape of the housing where the LED module is attached to the side surface of the housing, general view.

FIG. 7 shows the LED luminaire with dynamic convection cooling, comprising two interconnected housings with a longitudinal axis at an angle, general view.

FIG. 8 shows the LED luminaire with dynamic convection cooling, comprising four interconnected housings with the gap and with parallel longitudinal axes, general view.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0033] In a preferred embodiment, a LED lamp with dynamic convective cooling comprises at least one hollow housing (1) in the form of a segment of a hollow pipe of a thermally conductive material with open ends (2) and (3). On the outer surface of the housing (1) in close proximity to one of the open ends (2) or (3) there is attached a LED module (4), which is a LED light source, connected to a power source (not shown). In various cases of implementation the LED module (4) may be secured on the side surface of the housing (1) (Fig. 1-4) or on the end surface of the housing (1) (FIG. 5) with the possibility of entry of air into the inner cavity of the housing, e.g. via holes (5). The LED module (4) can be secured on the surface of the housing (1) via a releasable connection, such as screws (6) or a permanent connection, such as rivets (7) or adhesive (not shown), and so forth. Preferably, between the surfaces of the LED module (4) and the housing (1) a layer of the thermally conductive paste material (8) (Fig. 4) is placed. In various cases of implementation the LED luminaire can contain n (where $n \geq 2$) structurally interconnected hollow housings $(1)_1, (1)_2 \dots (1)_i, \dots (1)_n$, each of which $(1)_i$ represents a segment of a hollow pipe with open ends $(2)_i, (3)_i$, in close proximity of one of which the LED module $(4)_i$ is mounted. Housings $(1)_2 \dots (1)_i, \dots (1)_n$, may be interconnected via releasable $(6)_i$ or inseparable $(7)_i$ connections. Housings can be interconnected by a rigid connection (e.g., by welding or a connecting beam (9)), or a hinge, for example, by a lever rod connection (not shown). The housings $(1)_2 \dots (1)_i, \dots (1)_n$, may be interconnected in such a manner that their longitudinal axes y are arranged parallel (Fig. 9) or at the angle of 10° - 170° (Fig. 8) to each other; with a contact by the adjacent surfaces (Fig. 1-8) or with a gap λ between the last (Fig. 9). The housings may have a rectangular (Fig. 1-6), or square (not shown) or round (Fig. 7) or triangular, or figure shape (not shown). The preferred embodiment of the housing $(1)_i$ of the LED luminaire of the aluminum pipe of the rectangular section with the exterior dimensions of width d - 100.0 mm, height h - 30.0 mm, with a wall thickness s - 2.0 mm. The preferred length l of the housing $(1)_i$ is in the range of 0.2-0.5 m, and the power of the LED module $(4)_i$ is in the range of 20-70 W. Preferably, the LED luminaire comprises fastening means (10) to the mounting surface.

INDUSTRIAL APPLICABILITY

[0034] The invention operates as follows. The LED module (4)*i*, through the layer of a thermally conductive paste material (8) is attached at one of the open ends of the pipe, such as (2)*i* by means of releasable (6)*i* or inseparable (7)*i* connections. This end (2)*i* of the pipe becomes the input to the cold air. The opposite end (3)*i* of the pipe becomes the exit for the hot air. Preferably, in the operating position the open end (2)*i* of the pipe in close proximity of which the LED module (4)*i* is installed, is placed below the level of the opposite open end (3)*i* of the pipe, providing the slightly slanted or vertical position of the luminaire. When electric current starts to flow through the LED module (4)*i*, it is heated and it transmits heat through a thermally conductive composition to the side surface of the housing (1)*i*, and further - into the air space inside the cavity of the housing. As a result, in the inner cavity of the housing (1)*i* there is created a difference of temperatures at the entrance (open end (2)*i* of the housing (1)*i*, and on the side surface of the housing (1)*i*, that provides a natural convection. The cold air sucked through the entrance (open end (2)*i*), while passing through the airspace of the interior of the housing (1)*i* heated by the LED module, cools the LED module (4)*i*, and goes outside as heated through outlet (3)*i*.

Claims

1. A LED luminaire with dynamic convection cooling comprising at least one hollow housing made of a thermally conductive material, on the outer surface of which there is secured a LED light source connected to a power source, wherein the housing is a segment of a hollow pipe with open ends, whereas a LED module is used as the LED light source and installed in close proximity to one of the open ends of the housing.
2. The LED luminaire according to claim 1, wherein the LED module is secured on the side surface of the housing.
3. The LED luminaire according to claim 1, wherein the LED module is secured on the end surface of the housing with a possibility of entry of air into the interior of the housing.
4. The LED luminaire according to claim 1, wherein the LED module is secured on the surface of the housing by means of a releasable or permanent connection.
5. The LED luminaire according to claim 1, wherein in between the surfaces of the LED module and the housing a layer of the thermally conductive paste material is placed.
6. The LED luminaire according to any of claims 1 - 5, wherein it includes *n*, where $n \geq 2$, structurally interconnected hollow housings.
7. The LED luminaire according to claim 6, wherein the housings are interconnected by means of a releasable or permanent connection.
8. The LED luminaire according to claim 6, wherein the housings are interconnected by means of a rigid or hinged connection.
9. The LED luminaire according to claim 6, wherein the housings are interconnected so that their longitudinal axes are parallel to each other.
10. The LED luminaire according to claim 7, wherein the housings are interconnected so that their longitudinal axes are located to each other at an angle of range 10°-170°.
11. The LED luminaire according to claim 7, wherein the housings are interconnected with the adjacent contact surfaces.
12. The LED luminaire according to claim 6, wherein the housings are interconnected with a gap between the adjacent surfaces.
13. The LED luminaire according to any of claims 1 - 12, wherein each of the housings has a rectangular, or square, or circular, or triangular, or figure shape.
14. The LED luminaire according to any of claims 1 - 12, wherein the housing is made of an aluminum pipe of rectangular section with exterior dimensions of width - 100.0 mm, height - 30.0 mm, wall thickness 2.0 mm.
15. The LED luminaire according to any of claims 1 - 12, wherein the length of the housing is in the range of 0.5 m - 2 m.
16. The LED luminaire according to any of claims 1 - 12, wherein the output of the LED module is in the range of 20 - 70 W.
17. The LED luminaire according to any of claims 1 - 12, wherein it further comprises means for securing to the supporting surfaces.

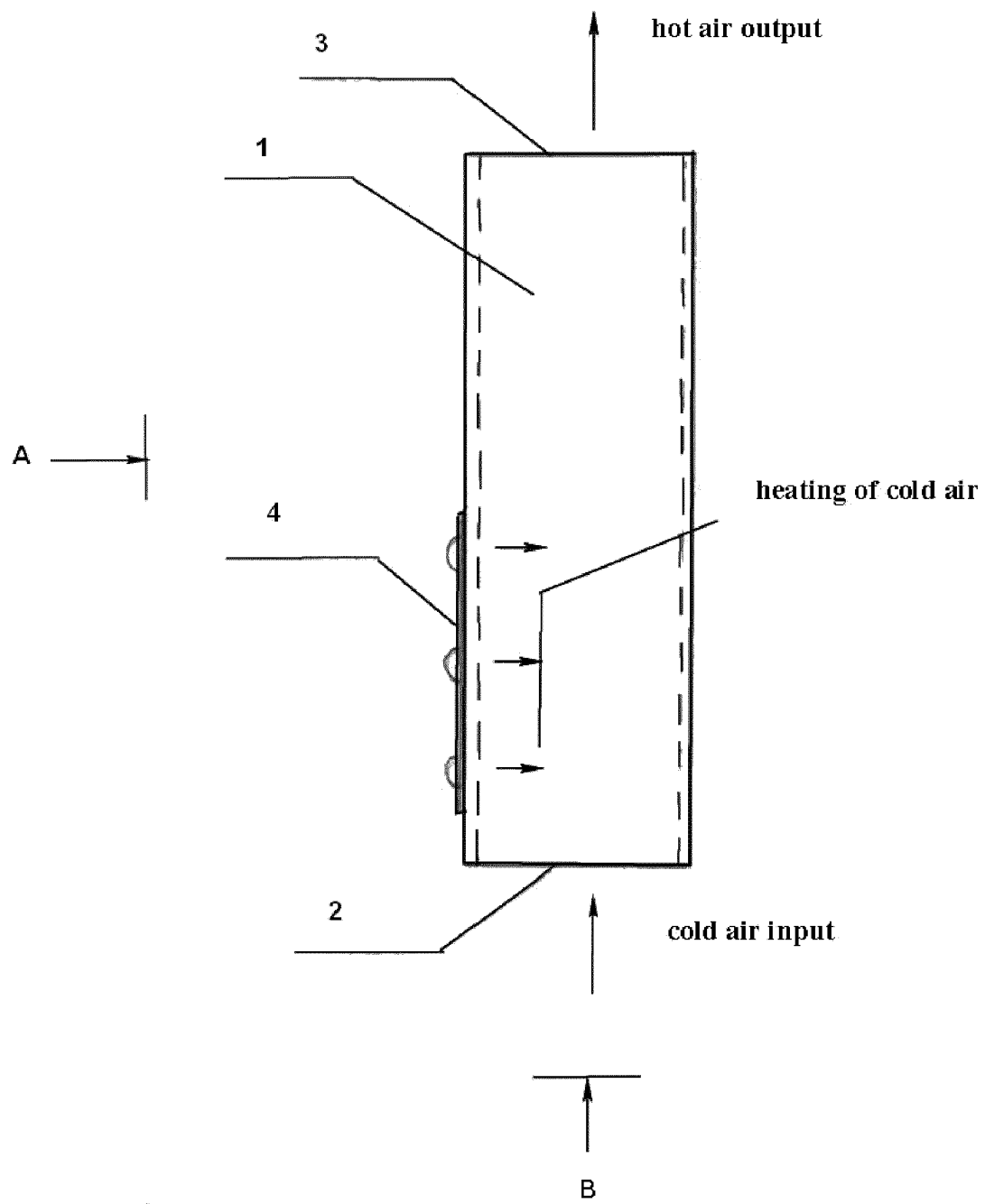


FIG.1

A

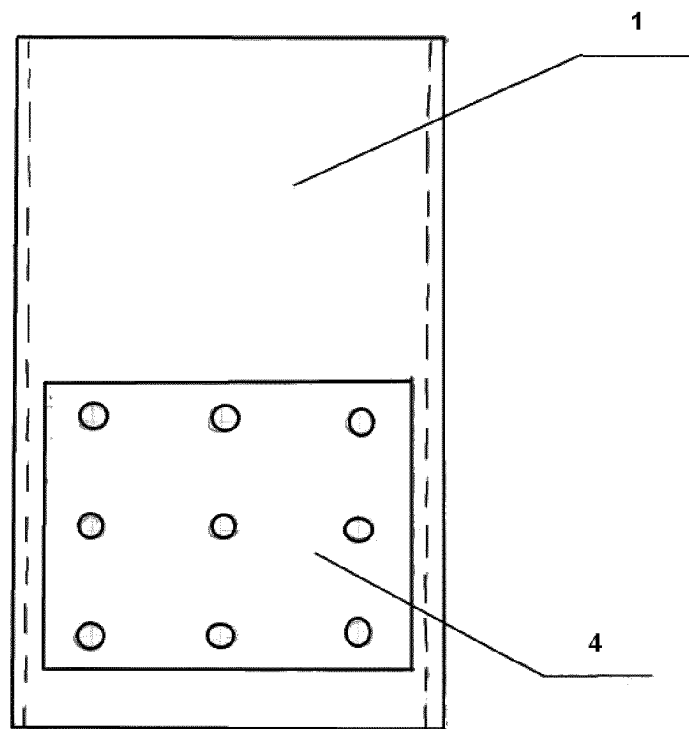


FIG. 2

B

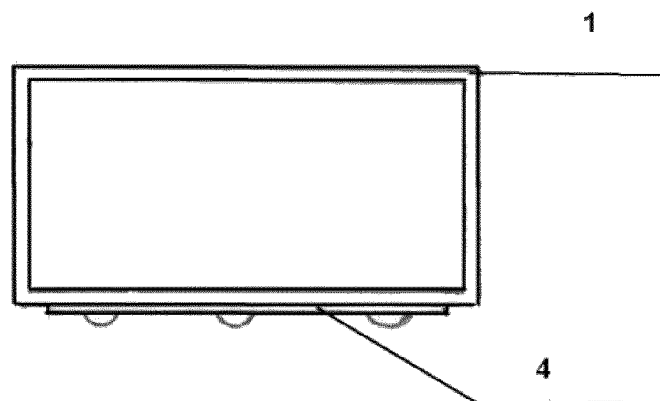


FIG. 3

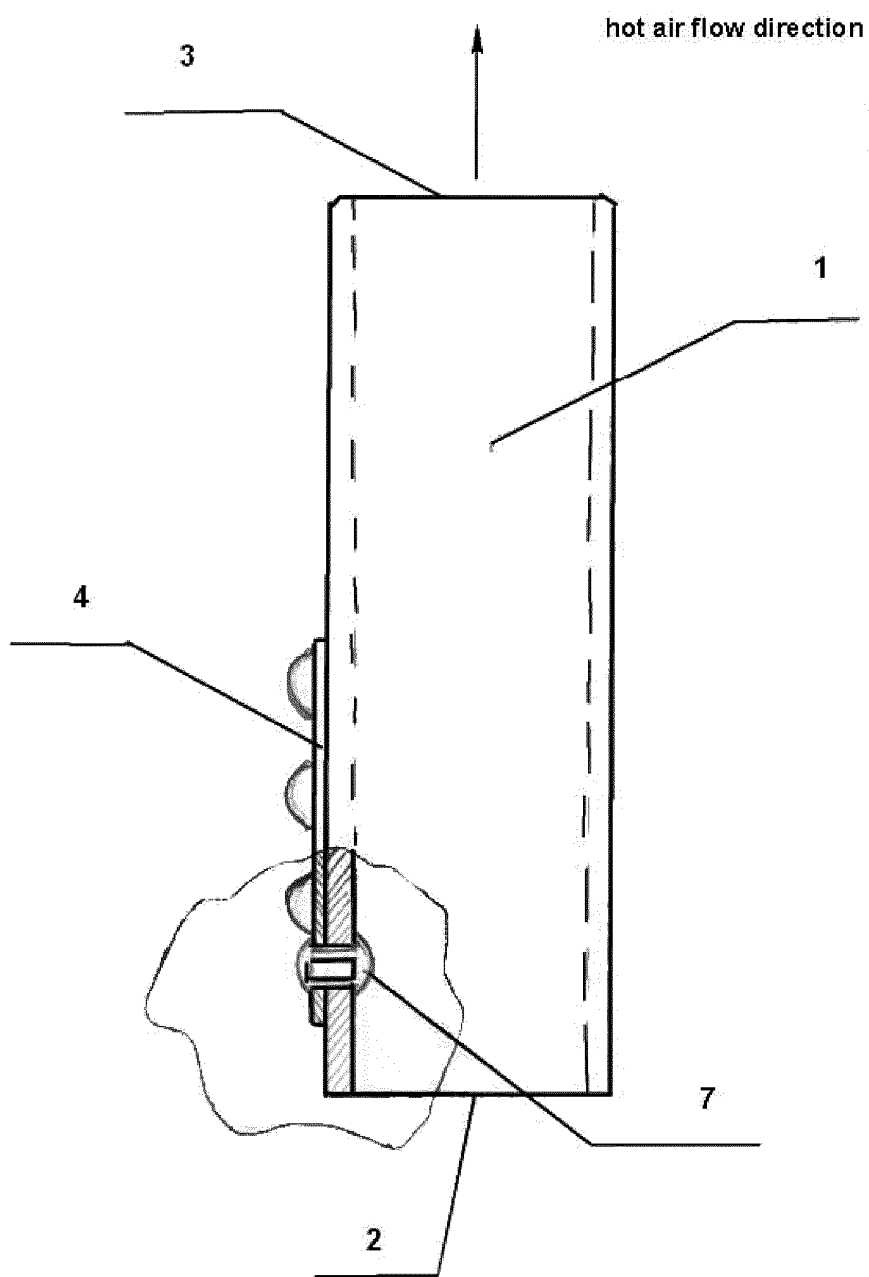


FIG. 4

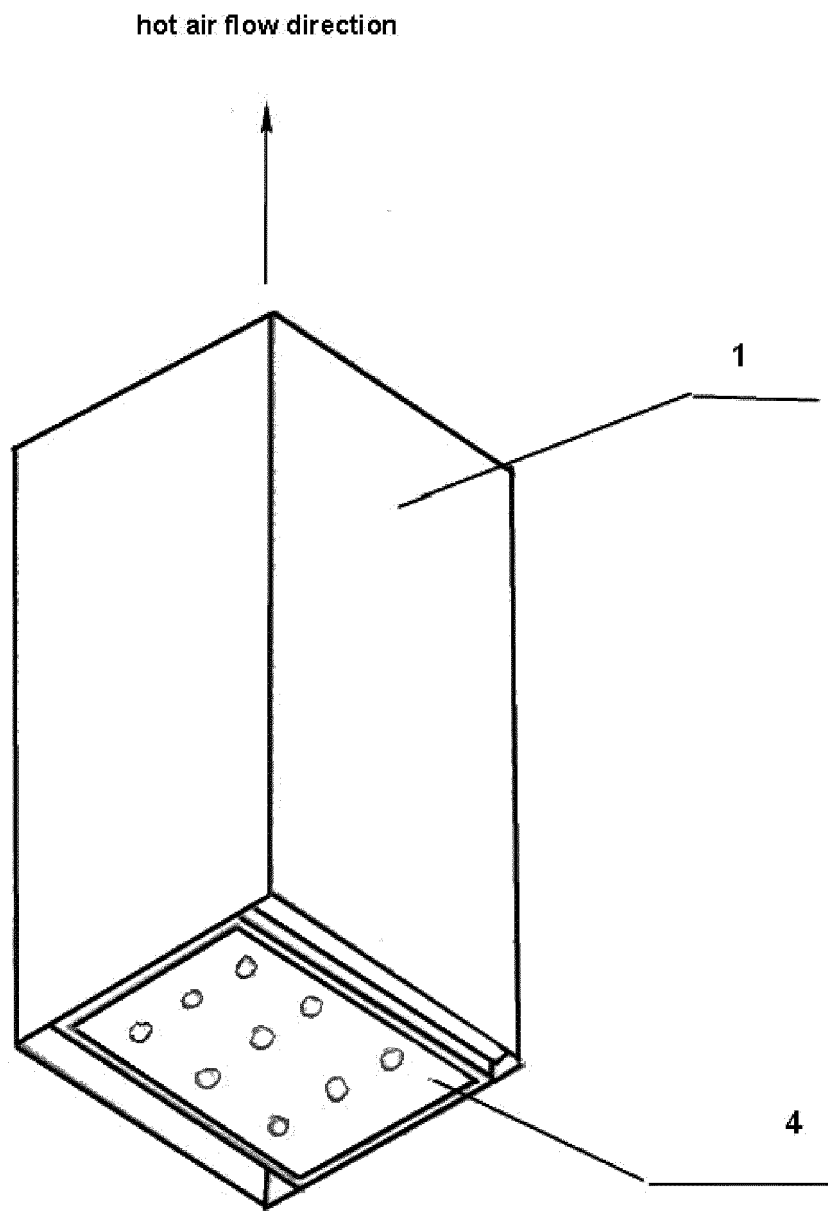


FIG. 5

hot air flow direction

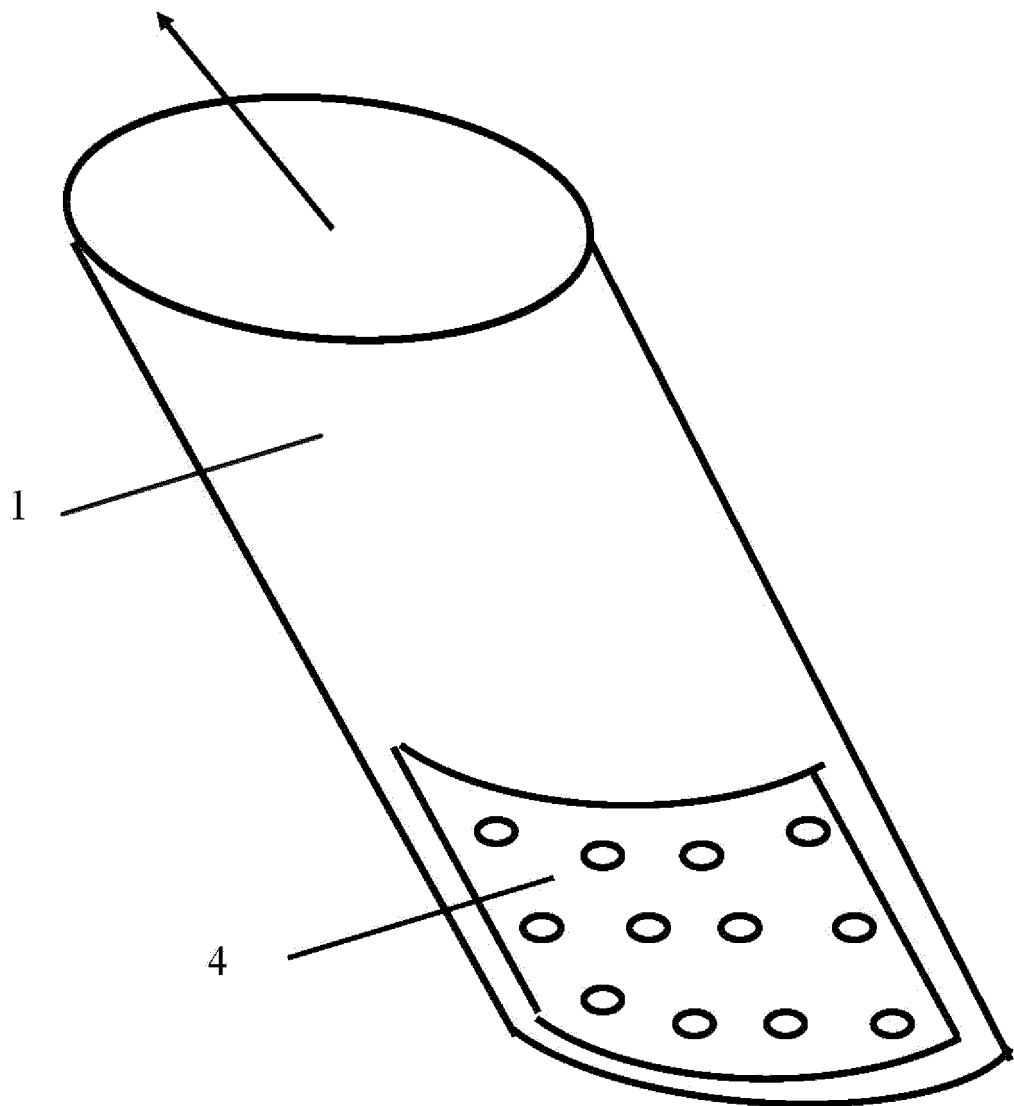


FIG. 6

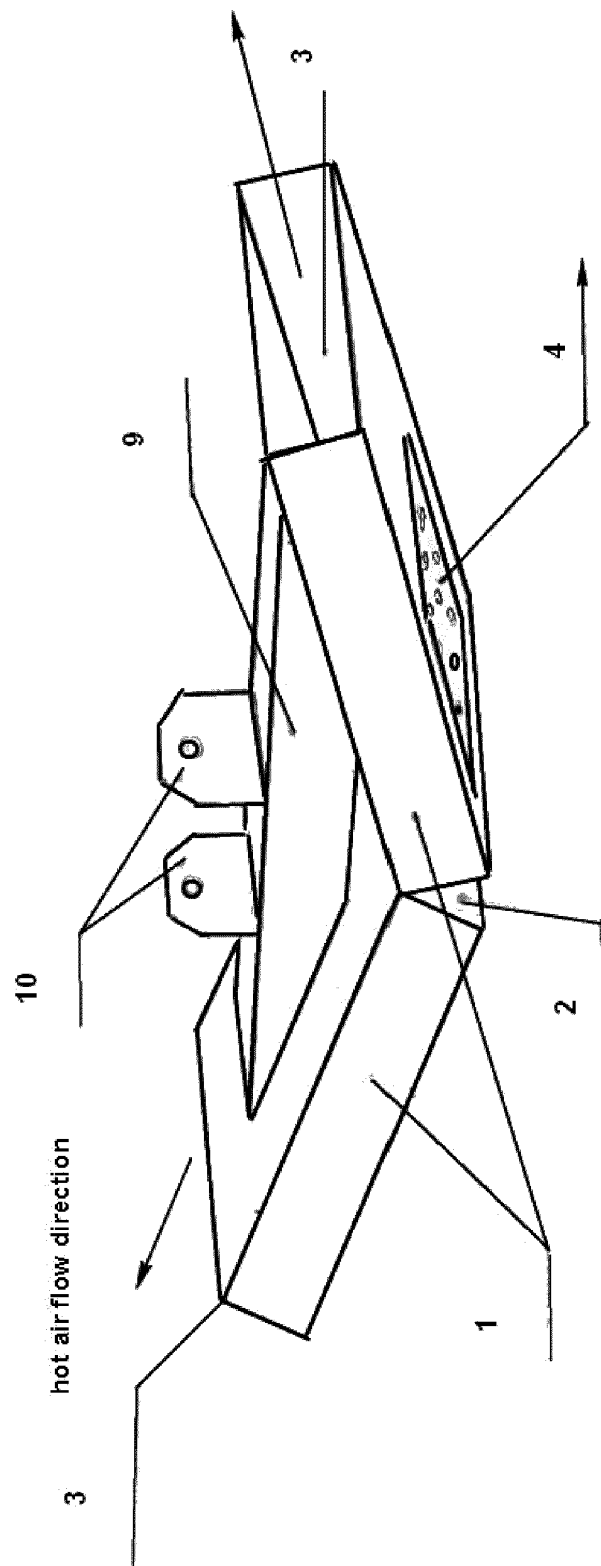


FIG. 7

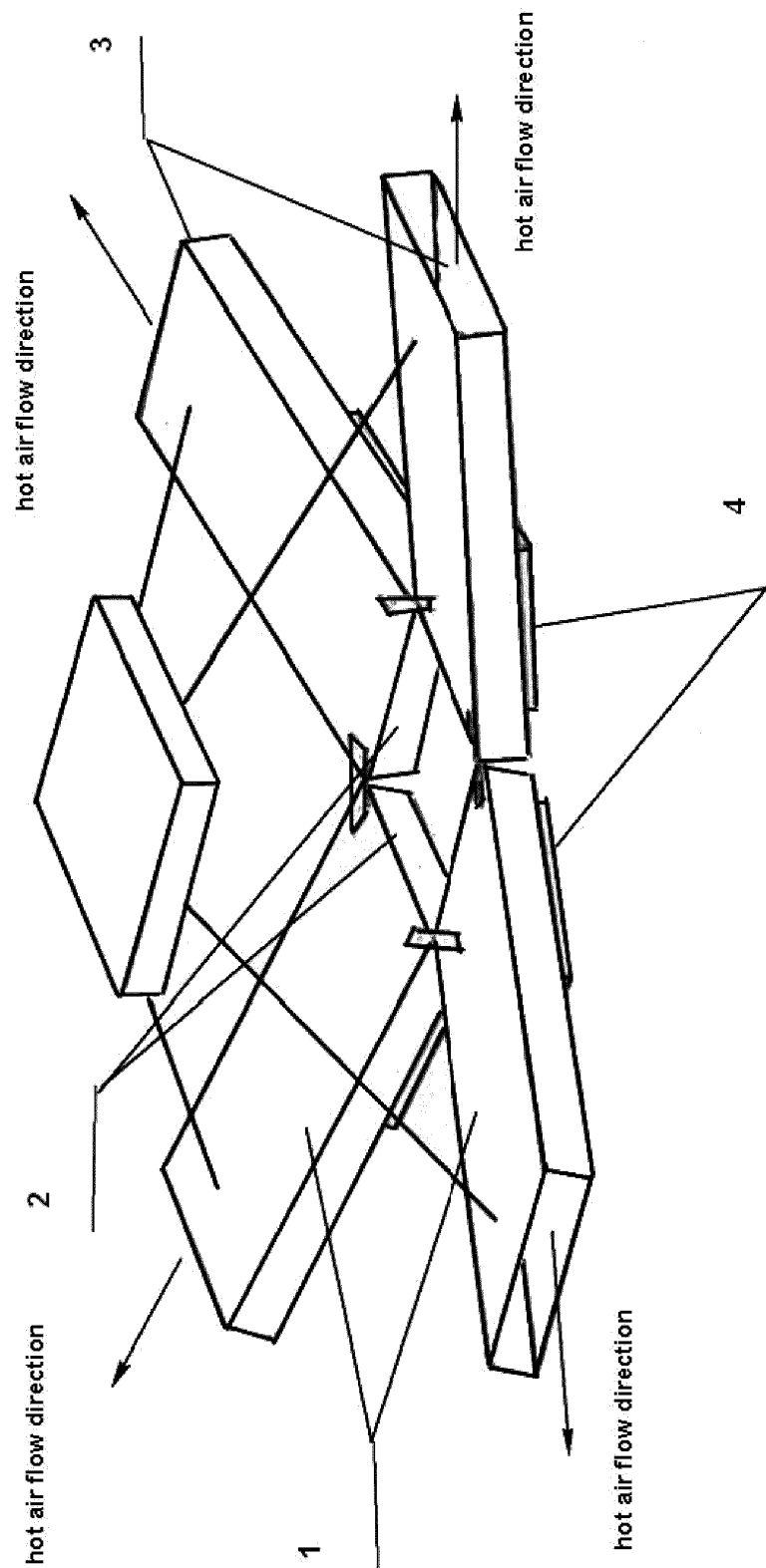


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/RU 2013/000153

A. CLASSIFICATION OF SUBJECT MATTER F21V 29/00 (2006.01); F21V 15/01 (2006.01); F21Y 101/02 (2006.01) According to International Patent Classification (IPC) or to both national classification and IPC																					
B. FIELDS SEARCHED																					
Minimum documentation searched (classification system followed by classification symbols) F21V 15/01, 29/00-29/02, F21S 2/00, F24F 3/056, 13/078, H05B 33/00-37/04, F21S 8/00-8/12, F21W 131/00, 131/205, F21Y 101/00-103/025																					
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																					
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet																					
C. DOCUMENTS CONSIDERED TO BE RELEVANT																					
<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>Y</td> <td>RU 2433577 C1 (ZAKRYTOE AKTSIONERNOE OBSHESTVO "METTEM-SVETOTEKHNKA") 10.11.2011, p. 3, lines 42-48, p. 4, lines 1-38, the claims, fig. 1-3</td> <td>1-8, 11, 13-17</td> </tr> <tr> <td>Y</td> <td>RU 2437128 C1 (POLISCHUK ALEKSANDR GENNADIEVICH) 20.12.2011, p. 2, lines 28-47, p. 3, lines 1-14, the claims, fig. 1, 2</td> <td>1-8, 11, 13-17</td> </tr> <tr> <td>Y</td> <td>RU 104281 U1 (KOGDANIN ARTEM IGOREVICH) 10.05.2011, the claims, p. 2, lines 20-43, p. 3, lines 8-24</td> <td>4, 6-8, 11</td> </tr> <tr> <td>Y</td> <td>RU 85784 U1 (ILCHUK VADIM ANATOLIEVICH) 10.08.2009, the claims, p. 2, lines 18-45, fig. 1</td> <td>2, 14-17</td> </tr> <tr> <td>Y</td> <td>WO 2008/093978 A1 (ZALMAN TECH CO. LTD. et al.) 07.08.2008, fig. 1, 17, the abstract</td> <td>3</td> </tr> <tr> <td>A</td> <td>WO 2009/039715 A1 (WANG QILIN) 02.04.2009</td> <td>1-17</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y	RU 2433577 C1 (ZAKRYTOE AKTSIONERNOE OBSHESTVO "METTEM-SVETOTEKHNKA") 10.11.2011, p. 3, lines 42-48, p. 4, lines 1-38, the claims, fig. 1-3	1-8, 11, 13-17	Y	RU 2437128 C1 (POLISCHUK ALEKSANDR GENNADIEVICH) 20.12.2011, p. 2, lines 28-47, p. 3, lines 1-14, the claims, fig. 1, 2	1-8, 11, 13-17	Y	RU 104281 U1 (KOGDANIN ARTEM IGOREVICH) 10.05.2011, the claims, p. 2, lines 20-43, p. 3, lines 8-24	4, 6-8, 11	Y	RU 85784 U1 (ILCHUK VADIM ANATOLIEVICH) 10.08.2009, the claims, p. 2, lines 18-45, fig. 1	2, 14-17	Y	WO 2008/093978 A1 (ZALMAN TECH CO. LTD. et al.) 07.08.2008, fig. 1, 17, the abstract	3	A	WO 2009/039715 A1 (WANG QILIN) 02.04.2009	1-17
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☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.																					
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